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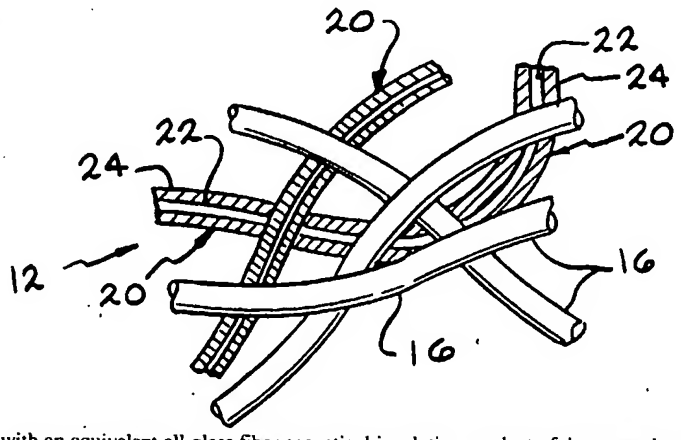


(57) Abstract: An acoustical insulation product (10) comprises primary glass fibers (16) and multi-component polymer fibers (20). The multi-component fibers are made of a principal polymer component (22) and a binder polymer component (24). The binder component has a softening point lower than the softening point of the principal component so that the insulation product can be heated to a temperature that is insufficient to soften the principal component but sufficient to soften the binder component to bond the multi-component polymer fibers to the primary fibers. The addition of the multicomponent polymer fibers to the primary glass fibers enhances the sound absorption properties of the acoustical insulation product when compared with an equivalent all glass fiber acoustical insulation product of the same glass fiber diameter and density.

WO 01/31131 A1

FIBROUS ACOUSTICAL INSULATION PRODUCT

TECHNICAL FIELD AND INDUSTRIAL APPLICABILITY OF THE INVENTION

This invention relates to fibrous acoustical insulation products and methods of manufacturing fibrous acoustical insulation products. More particularly, this invention pertains to making fibrous acoustical insulation products having a binder material for connecting the primary insulation fibers to one another to impart structural integrity to the insulation product, and to enable the insulation product to have good sound absorption qualities.

BACKGROUND OF THE INVENTION

Fibrous insulation is commonly formed by fiberizing molten material and depositing the fibers on a collecting conveyor. Some fibrous acoustical insulation products are made by transporting fibrous material through various secondary processes, such as wet processes, air laid processes, reorienting, carding, blending of different types of fibers, or other processes for forming a blanket of fibrous material. Typically the fibers for acoustical insulation products are mineral fibers, such as glass fibers, although some acoustical products are made of organic fibers, such as polyester. Most fibrous acoustical insulation products contain a binder material to bond the fibers together where the fibers contact each other. A typical binder material for glass fiber acoustical insulation is a thermosetting urea phenol-formaldehyde binder that is applied to the glass fibers before they are collected on the collecting conveyor. The binder is cured by passing the bindered insulation product through an oven. In some products, the binder gives the acoustical insulation product resiliency for recovery after packaging. In most acoustical insulation products the binder provides stiffness and handleability so that the product can be handled and applied as needed in the intended use for the acoustical insulation. Typical applications for acoustical insulation include sound screens and other interior products, appliances, heating, ventilating and air conditioning (HVAC) equipment, vehicles, and industrial applications. The binder also enables the insulation material to be molded into various shapes as needed. An important product attribute of such acoustical insulation

products is good acoustical performance, typically both in absorbing sound energy and in blocking the transmission of sound energy.

Attempts have been made to improve upon the urea phenol-formaldehyde binder used in conventional fiberglass acoustical insulation products. Acoustical insulation products having conventional binder must be cured in an oven typically at a temperature of about 450°F (232°C). Such a binder is water based, and curing the binder can only occur after driving off all the water. This requires a large amount of energy. Before the curing stage, the binder flows along the fibers to the fiber-to-fiber intersections. After the binder in a conventional product is cured, a significant percentage of the urea phenol-formaldehyde binder is in the form of lumps or pieces (beads) of solid material at the fiber-to-fiber intersections rather than in a fine surface coating or a fine connection from fiber to fiber. These non-fibrous lumps or pieces have a very low surface-area-to-mass ratio, and therefore do not provide any significant acoustical advantage. It would be advantageous if there could be developed an acoustical insulation product that provided a smaller portion of the binder material in non-fibrous form, thereby maximizing the surface area of the material for both acoustical benefits.

Another problem with the application of conventional binder materials is that applying the binder in a liquid form provides an opportunity for some of the binder material to escape as volatile or particulate organic materials, thereby necessitating expensive environmental protection procedures and equipment. Manufacturing fibrous acoustical insulation would be improved if the formation of volatile or particulate organic materials could be eliminated or reduced. Also, conventional bindered insulation products can be irritating when handled, and improvements to eliminate or reduce the scratchiness of insulation products would be helpful.

Marzocchi in U.S. Patent No. 4,224,373 discloses intermingling previously formed mono-component polymer binder fibers into an air-borne flow of glass fibers to form a sheet-like nonwoven textile or fibrous mat. Alternatively, the process can be used to form a tow, which is a linear collection of intermingled fibers similar to twine or rope. Marzocchi's process involves directing the binder fibers, which are of lesser diameter than the primary fibers, into contact with the primary glass fibers. The Marzocchi product is not intended for use as an acoustical insulation product.

U.S. Patent Nos. 5,490,961 and 5,736,475 to Bakhshi et al. disclose coaxial spinners for simultaneously forming glass fibers and polymer fibers. The Bakhshi patents also teach that some of the fibrous polymer material is heated in the fiber forming region to the extent that some of the polymer material softens but remains attached to the glass fibers as non-fibrous material, while some of the polymer material remains as fibers. Attempts to make commercially viable insulation products using the Bakhshi process have not been successful because, in part, of the extreme variability of the process due to the complex flow and temperature patterns of the fiber forming region.

U.S. Patent No. 4,237,180, to Jaskowski, discloses a wet process for making a thermal and acoustical insulation product that includes a blend of glass wool and mono-component polymer fibers. A liquid binder is applied. In a subsequent manufacturing step the blend of glass wool and polymers is subjected to heat to shrink the polymer fibers in order to interlock the polymer fibers with the glass wool fibers. The interlocking can also be accomplished by needling.

U.S. Patent No. 5,316,601 to Hebbard at al. discloses a fiber blending system for making a mat or paper towel of blended cellulose fibers (that is, wood) and polymer fibers. The polymer fibers can be bicomponent fibers. A thermobonding process causes at least one of the organic components to fuse the mat and form a core product. During the manufacturing process a fiber opening machine of opening and fluffing the polymer fibers. All of the fiber opening machines are positioned serially so that the output from any of the fiber opening machines is delivered into each of the downstream opening machines. This product is primarily aimed at hygiene applications because of the good moisture absorption of the cellulose fibers. There is no suggestion that this process can be used for insulation products having good thermal values.

U.S. Patent No. 5,298,694 to Thompson et al. discloses an acoustical insulation product adapted to be applied to the panel of an inner door. The acoustical product comprises fine staple polymers mixed with bicomponent thermally activated binder fibers. The fibrous mixture is air laid to form the acoustical insulation product.

Although the above-mentioned practices have provided new opportunities for efficiencies, and in some cases new products, there is still a need for an acoustical insulation product, and a process for making such a product, that would reduce the solid binder lumps at the fiber-to-fiber intersections, operate in a dry manufacturing

environment, and also provide even greater acoustical insulation values. Such a product or process should exhibit a reduction in or elimination of volatile or particulate organic materials, and exhibit reduced skin irritation when handled. Further, such a product or process should enable a reduction in the energy used during manufacturing. Another desirable attribute for such products or processes is the ability to tailor the acoustical insulating properties of the product for various customer needs. It would be especially preferable if there could be developed a process that provides flexibility to the products to allow the use of different fibers having various characteristics, particularly those fibers such as glass fibers that have higher melting points and lower cost than polymer fibers.

SUMMARY OF THE INVENTION

The above objects as well as other objects not specifically enumerated are achieved by an acoustical insulation product comprising primary mineral fibers and multi-component polymer fibers. The multi-component fibers are made of a principal polymer component and a binder polymer component. The binder component has a softening point lower than the softening point of the principal component so that the insulation product can be heated to a temperature that is insufficient to soften the principal component but sufficient to soften the binder component to bond the multi-component polymer fibers to the primary fibers. The addition of the multicomponent polymer fibers to the primary glass fibers enhances the sound absorption properties of the acoustical insulation product when compared with an equivalent all glass fiber acoustical insulation product of the same glass fiber diameter and density.

According to this invention, there is also provided an acoustical insulation product comprising primary glass fibers and bicomponent fibers, where the bicomponent fibers having a principal polymer component and a binder polymer component. The binder component has a softening point lower than the softening point of the principal component. At least a portion of the binder polymer component has been heated to bind the bicomponent fibers and the primary fibers to themselves and to each other. The addition of the bicomponent polymer fibers to the primary fibers enhances the sound absorption properties of the acoustical insulation product when compared with an equivalent all glass fiber acoustical insulation product of the same glass fiber diameter and density.

Various objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view in perspective of an insulation product according to the present invention.

Figure 2 is a schematic view more detailed view of a portion of the fibers of the insulation product of Fig. 1.

Figure 3 is a schematic view in elevation of the fiber opening portion of an apparatus for making another insulation product according to the present invention.

DETAILED DESCRIPTION AND PREFERRED EMBODIMENTS OF THE INVENTION

The insulation product of the invention, illustrated at 10 in Fig. 1, is comprised of fibers 12. The insulation product 10 may or may not be in the form of a molded product. A facing, not shown, or encapsulation material 14, can optionally be placed on the product. The facing material can be any suitable material, such as a film, a foil or an open web such as a scrim. As shown in Fig. 2, the fibers 12 typically include primary fibers 16 and multicomponent fibers, in the form of bicomponent polymer fibers 20. It is to be understood that although bicomponent fibers are illustrated, other multicomponent fibers, such as tricomponent fibers, can be used with the invention. For purposes of clarity, the bicomponent polymer fibers 20 are shown in cross-section, while the primary fibers 16 are not. The bicomponent polymer binder fibers 20 are comprised of a principal polymer component 22 and a binder polymer component 24. The bicomponent polymer fibers 20 are shown as having been formed as sheath-core fibers, with the principal polymer component 22 forming a core material and the binder polymer component 24 forming a sheath around the core. It is to be understood that the bicomponent polymer fibers 20 can be formed in other arrangements, such as in a side by side arrangement, not shown. It can be seen that the binder polymer component 24 binds the bicomponent polymer fibers 20 and the primary fibers 16 to themselves and to each other.

The primary fibers 16 can be any type of fibers suitable for providing good structural qualities as well as good acoustical and thermal properties. Preferred fibers for use as the primary fibers 16 are wool glass fibers. It is to be understood that the primary fibers can specifically be any mineral fibers such as fibers made of rock, slag and basalt, as well as glass fibers. Wool glass fibers are well known in the art, and are usually made by the rotary process, typically having a diameter within the range of from about 3 to about 30 microns. If wool glass fibers are used, they can be generally straight conventional fibers, or they can be irregular fibers such as Miraflex® fibers from Owens Corning Miraflex® fibers are bicomponent fibers formed by the rotary process as described in U.S. Patent Nos. 5,536,550 and 5,431,992, herein incorporated by reference. Another example of primary fibers that could be used with the invention is using polyethylene terephthalate (PET) fibers having a diameter within the range of from about 3 to about 30 microns. The primary fibers are preferably present in an amount that is within the range of from about 30 to about 95 percent by weight of the whole insulation product, exclusive of facings, and the bicomponent fibers are preferably present in an amount within the range of from about 25 to about 70 percent by weight. Most preferably, the primary fibers are glass fibers that are present in an amount that is within the range of from about 40 to about 80 percent by weight of the whole insulation product, exclusive of facings, and the bicomponent binder fibers are present in an amount within the range of from about 20 to about 60 percent by weight.

The introduction of the bicomponent polymer binder fibers 20 into the primary fibers serves two purposes. First the binder polymer component 24 supplies the binder necessary to bond the insulation product 10 together. Second, the bicomponent binder fibers are integrated as additional insulating fibers within the insulation product 10 to provide additional insulative value beyond that of the primary fibers 16. This additional acoustical and thermal insulative value is mainly derived from the additional fiber surface area of the bicomponent binder fibers which serves to block heat transfer by radiation through the insulation product, and also acts as a sound barrier and/or absorber. The addition of the bicomponent binder fibers adds not only the bonding capability, but also increases the strength of the product.

The binder polymer component 24 of the bicomponent polymer binder fibers 20 has a softening point lower than the softening point of the principal polymer component

22 so that upon heating the insulation product, the two materials will respond differently. More specifically, the insulation product 10 can be heated to a temperature that is above the softening point of the binder polymer component 24, but is below the softening temperature of the principal polymer component 22. This will cause the binder component to soften and become sticky, thereby bonding the various bicomponent polymer binder fibers 20 to themselves where they are in contact. Also, the softening of the binder polymer component 24 will bond the primary fibers 16 to themselves, and will bond the bicomponent polymer binder fibers 20 to the primary fibers 16. As long as the temperature is not raised as high as the softening point of the principal polymer component 22, that component will remain in the form of fibers. A particular advantage in using a binder polymer component 24 that is raised to its softening point is that the polymer binder material will not exhibit a significant flow during the heating process. With a non-flowing binder system there will be fewer undesirable binder particles or beads that are typically formed at the fiber-to-fiber intersections of prior art insulation products. The urea phenol-formaldehyde binder systems of the prior art produce a product with a large number of these beads. Without these beads, the product of the present invention has a lower product K value or an increased resistance to flow of heat through the insulation product. Another result is higher surface area and air resistively for good acoustic performance.

Many combinations of materials can be used to make the bicomponent polymer binder fibers 20, including combinations using PET (polyester), polypropylene (PP), polysulfide, polyolefin, and polyethylene (PE), as well as other fibers. Combinations for the principal component/binder component can include PET/PP, PET/PE, PET/PET and PP/E. Typical combinations are PET/PET and PP/PE. The binder polymer component 24 can be made so that it has a softening point within the range of from about 150°F (65°C) to about 400°F (204°C), and more preferably within the range of from about 170°F (77°C) to about 300°F (149°C). Most preferably the binder polymer component 24 is a thermoplastic material, which for purposes of this invention is defined as a low temperature heat-softenable plastic material, so that it can be subjected to multiple molding processes if desired. The principal polymer component 22 has a higher softening point, preferably above about 300°F (149°C), and most preferably above about 350°F (177°C).

The method of making the insulation product of the invention will now be described with reference to Fig. 3. As shown in Fig. 3, two bale openers 30 and 32 are positioned to receive fibers from various sources, and to deliver their respective opened fibers into a pneumatic conveyor 34 for delivery in a downstream direction for further processing. The bale openers 30 and 32 mechanically and/or pneumatically decouple the clustered fibrous masses of the input stock so that fiber contact becomes fiber-to-fiber rather than bundle-to-bundle. This increases the surface area of the total fiber collection, thereby increasing the thermal and acoustical properties of the ultimate insulation product. The pneumatic conveyor 34 can be powered by any suitable means, such as by a fan 36. It is to be understood that a mechanical conveyor or any other type of conveyor could also be used. The use of a closed conveyor system reduces the proliferation of dust into the plant environment. The two bale openers 30 and 32 can be different or can be substantially identical. The bale openers 30 and 32 typically include a generally vertical lattice board conveyor, beater rolls, and lickering drums. Such apparatus is well known in the art. The bale openers 30 and 32 separate and untangle the fibers from each other, thereby producing an output of fibrous material that can be more easily mixed and homogenized with other fibers to ultimately make a uniformly blended insulation product. Any fiber opening device can be used for the bale opener as long as it is capable of opening and separating the fibers for further processing. Suitable bale openers are available from numerous sources, including Arcatex Inc., Spartanburg, SC, American Truetzchler Inc., Charlotte, NC, Fleissner GmbH & Company, Egelsbach, Germany, Hollingsworth, Greenville, SC, Rando Machine Corporation, Macedon, NY, Rieter Corporation, Spartanburg, SC, N. Schlumberger (USA) Inc., Fort Mill, SC, Schott & Meissner Maschinen, Blaufelden, Germany, Sigma Corporation, Simpsonville, SC, and Spezialmaschinen DOA GmbH & Co. KG, Wels, Austria. One of the advantages of using bale openers in making the insulation product 10 is that scrap wool glass fibers can be recycled and added to the fibrous mix.

The advantage of having two different bale openers 30 and 32 is that they can be used to handle two different types of fibers, each having different characteristics. The blend ratio is controlled by the individual throughput of these two bale openers. Bale openers 30 and 32 may be positioned in parallel, rather than in series, so that each can be configured to develop its own stream of opened fibers, and to supply those fibers to the

pneumatic conveyor 34 in the desired blend ratio. As an example, for an insulation product of the invention in which the primary fibers are 12.5 micron PET fibers, and in which the bicomponent fibers are 14.5 micron sheath-core fibers having PET as the core and PET as the lower softening sheath material, bale opener 30 can be set up to handle the primary fibers, and bale opener 32 can be arranged to handle the PET/PET bicomponent polymer fibers.

The output from the bale openers 30 and 32 is conveyed via the pneumatic conveyor 34 to the consolidation apparatus 48, also shown in Fig. 6. The consolidation apparatus includes a volumetric feeder 50 having condenser rolls 52 and a vertical accumulator 54 that collects the fibers from condenser rolls 52 and feeds the fibers to another set of lickering drums 56. The purpose of the consolidation apparatus 48 is to collect fibers from the bale openers 30 and 32, blend them together, and open the blended fiber mixture further for good fiber-to-fiber intermingling. The additional opening power provided by the two parallel bale openers may necessitate additional blending power, such as the blending capability of the consolidation apparatus 48. Typical sheet formers cannot successfully handle fibers below about 3.0 denier at economically viable throughputs, but the use of the consolidator 48 enables fibers having a denier as low as about 1.5 to be processed. The output from the consolidation apparatus 48 is conveyed by pneumatic conveyor 58 downstream for further processing. Any suitable fiber consolidation apparatus can be used, such as, for example, machinery available from the manufacturers listed above.

A supplemental fiber opening device, indicated at 64 in Figs. 3 and 5, is positioned to add additional fibers to the pneumatic conveyor 58. The opening device 64 differs from the bale openers 30 and 32 in that there are a reduced number of lickering drums 66, in contrast to the number of lickering drums 42 in the bale opener 32. The opening device 64 is specifically adapted to work with fibers that do not require as much opening, or with brittle fibers, and therefore the opening device has a lesser amount of opening power than the bale openers 30 and 32. Since the output of the opening device 64 is directed into the pneumatic conveyor 58, the glass fibers from the opening device 64 are not required to pass through either of the bale openers 30 and 32, or through the consolidation apparatus 48. Therefore, the opening device 64 is not arranged in serial with bale openers 30, 32 and consolidator 48, but rather is in a parallel relationship. In bypassing the openers, 30,

32 and consolidator 48, the glass fibers can be maintained at a reasonable length, and will not be broken into undesirably short fibers. Any supplemental fiber opening device suitable for use with glass fibers can be used, such as, for example, those available from the manufacturers listed above, as well as from other manufacturers.

Another advantage gained by providing the supplemental opening device 64 in addition to bale openers 30 and 32 is that there are three entry points for fibers to be introduced into the ultimate fiber stream. This allows improved flexibility, boosts production, and enables the insulation products of the invention to be manufactured with great efficiency. With three fiber input devices, three different type of fibers, each having different characteristics, can be treated differently and separately introduced to make up the desired fiber mix needed for the insulation product. Each of the opening machines, 30, 32 and 64 can be configured and adapted to provide the type of opening suitable for the input fiber being processed through the machine. Since fibers introduced into the fibrous collection through bale openers 30 and 32 are subsequently passed through the consolidation device 48, there is more opening power for fibers introduced through bale openers 30 and 32. For example, if the primary fiber is a fine polymer fiber, then it may be relatively difficult to open, and it should be introduced in bale opener 30 or 32, whereas if the primary fiber is relatively coarse, it can be introduced in the supplemental opening device 64.

Once the fibers are properly opened by the fiber opening devices 30, 32 and 64, the opened fibers are directed via the pneumatic conveyer 58 to a main condenser and subsequent sheet formers. Suitable sheet formers are well known in the art, and are available from several different manufacturers, such as the manufacturers listed above. The use of binder fibers rather than a water-based liquid binder enables the first sheet former 86 to be operated in a dry condition.

After sheet forming, the blanket can be processed by needling or other mechanical bonding process and may be subsequently.

EXAMPLE 1

An insulation product was made according to the present invention. First, bicomponent PET/PET (2.0 denier) fibers having a diameter of about 14.3 microns were introduced to, and processed through a fiber opening process. The bicomponent fibers

were in a core/sheath arrangement. The core had a melting temperature of about 490°F (254°C) and the sheath became soft and sticky at a temperature of about 235°F (113°C). Glass wool primary staple fibers, formed by a rotary process and having a diameter of about 7 microns, were introduced to the bicomponent fibers, and the two types of fibers were intermingled to form a blanket. The glass wool primary fibers constituted about 70 percent by weight of the total blanket, and the PET/PET bicomponent fibers constituted about 30 percent. The resulting blanket was subsequently subjected to a heat bonding process in an oven to soften the binder polymer component and bond the primary glass wool fibers and the bicomponent fibers to themselves and to each other. After bonding, both the primary glass wool fibers and the bicomponent PET/PET polymer fibers retained their fibrous shape. The blanket had a density of about 1.0 pounds per cubic foot (16.01 kilograms per cubic meter) at a thickness of about 1.0 inches (2.54 centimeters).

The resulting product exhibited a smoother feel than conventional glass wool products, thereby generating less irritation when handled. The process was a completely dry process, and consequently environmental problems were minimal or nonexistent. Since there was no liquid based binder and no curing process, there was no requirement for drying, and no odor or smoke was generated. The product had a uniform color.

EXAMPLE 2

An insulation product was made in the same manner as that of the insulation product in Example 1 above with about 70 percent by weight glass wool fibers and about 30 percent by weight bicomponent PET/PET polymer fibers. A one inch thick sample of the insulation product of Example 2 was tested for thermal properties using a K-tester, according to ASTM C-518. K value is measured in Btu-in/hr-ft^2-°F. The K-value of the product of Example 1 was about 0.264, whereas the expected K-value of an equivalent one inch thick 100 percent glass wool product (7 micron, 1.0 pcf density, 5 percent by weight urea phenol-formaldehyde binder) would be about 0.271. Therefore, the lower K-value of the product of Example 2 provides a better thermal insulation value what would be expected from an all glass wool product.

EXAMPLE 3

Several insulation products were made according to the method disclosed in Example 1. The K-values for these products were tested and compared with equivalent 100 percent glass wool products having the same glass fiber diameter (7 microns) and the same density. In the glass fiber/polymer fiber products the polymer fibers were bicomponent core/sheath fibers. The results are shown in Table 1.

TABLE 1

Percentage Glass fibers/ polymer fibers	Polymer material core/sheath, Diameter	Density (pcf)	K-value of glass/polymer product	K-value of equivalent 100 % glass wool
70%/30%	PET/PET 14.3 micron	1.00	0.264	0.271
70%/30%	PET/PET 14.3 micron	1.50	0.243	0.251
70%/30%	PET/PET 14.3 micron	2.00	0.235	0.242
70%/30%	PET/PET 14.3 micron	2.50	0.231	0.237
70%/30%	PET/PET 14.3 micron	3.00	0.230	0.235
70%/30%	PP/PE 17.5 micron	2.00	0.242	0.242
70%/30%	PP/PE 17.5 micron	2.50	0.237	0.237
70%/30%	PP/PE 17.5 micron	3.00	0.234	0.235

The data from Table 1 shows that there is an overall lowering of the K-value when the PET/PET core/sheath bicomponent fibers are added to the glass wool fibers, whereas the K-value of the PP/PE core/sheath bicomponent fibers was equivalent to the K-value of the glass wool fibers.

EXAMPLE 4

An experimental insulation product was made according to the method of the invention, as disclosed in Example 1. The insulation product comprised 70 percent by weight irregular glass wool fibers (7 micron) and 30 percent by weight PET/PET core/sheath bicomponent fibers, having a diameter of about 14.32 microns. The acoustical (sound absorption) properties of the experimental insulation product were measured according to ASTM E-1050 and compared with a control insulation product comprising 100 percent by weight irregular glass wool fibers (7 micron) having 5 percent by weight urea-phenol/formaldehyde binder. Both the experimental insulation product and the control were maintained at a thickness of about 1.0 inches (2.54 centimeters) and at a density of about 1.0 pound per cubic foot (16.01 kilograms per cubic meter). The results of the acoustical testing are shown in TABLE 2 below.

TABLE 2

Frequency (Hz)	Glass-PET/PET 70/30%	100 % Glass Wool
100	0.016	0.015
125	0.025	0.024
160	0.040	0.038
200	0.059	0.056
250	0.060	0.052
315	0.083	0.079
400	0.122	0.114
500	0.155	0.153
630	0.210	0.200
800	0.276	0.256
1000	0.347	0.318
1250	0.428	0.389
1600	0.528	0.478
2000	0.623	0.565
2500	0.715	0.654
3150	0.794	0.735

It can be seen that the experimental insulation product of the present invention exhibited enhanced sound absorption properties over all the frequencies tested when compared with an equivalent 100% glass fiber acoustical insulation product of the same glass fiber diameter and density.

When the same experimental insulation product of the present invention and control product were tested for noise reduction coefficient, it was found that the noise reduction coefficient of the product of the invention had a noise reduction coefficient of 0.300 when compared with a noise reduction coefficient of 0.272 for the control product.

The principle and mode of operation of this invention have been described in its preferred embodiments. However, it should be noted that this invention may be practiced otherwise than as specifically illustrated and described without departing from its scope.

WHAT IS CLAIMED IS:

1. An acoustical insulation product (10) having enhanced sound absorption properties, comprising primary fibers (16) and multi-component polymer binder fibers (20) that are made of a principal polymer component (22) and a binder polymer component (24), the binder component having a softening point lower than the softening point of the principal component so that the insulation product can be heated to a temperature that is insufficient to soften the principal component but sufficient to soften the binder component to bond the multi-component polymer binder fibers to the primary fibers.

2. The acoustical insulation product (10) of claim 1 wherein the multi-component polymer binder fibers (20) have an initial diameter, prior to the softening of the binder component, that is within the range of from about 3 to about 40 microns.

3. The acoustical insulation product (10) of claim 1 in which the primary fibers (16) are wool glass fibers.

4. The acoustical insulation product (10) of claim 3 wherein the glass fibers (16) are bicomponent glass fibers.

5. The acoustical insulation product (10) of claim 1 in which the primary fibers (16) have a diameter within the range of from about 3 to about 30 microns.

6. The acoustical insulation product (10) of claim 5 in which the primary fibers (16) have a diameter within the range of from about 3 to about 15 microns.

7. The acoustical insulation product (10) of claim 5 in which the primary fibers (16) have a diameter within the range of from about 5 to about 9 microns.

8. The acoustical insulation product (10) of claim 1 in which the binder component (24) is a thermoplastic material.

9. The acoustical insulation product (10) of claim 1 in which multicomponent binder fiber (20) is a bicomponent fiber.

10. The acoustical insulation product (10) of claim 9 in which the principal polymer component (22) and binder polymer component (24) are in a sheath-core arrangement.

11. The acoustical insulation product (10) of claim 10 in which the bicomponent binder fibers (20) include a core of polyethylene terephthalate and a sheath of polyethylene terephthalate.

12. The acoustical insulation product (10) of claim 1 wherein the acoustical insulation product has been subjected to a mechanical interlocking process for enhancing product integrity.

13. The acoustical insulation product (10) of claim 12 in which the acoustical insulation product has been subjected to a needling process for enhancing product integrity.

14. An acoustical insulation product (10) having enhanced sound absorption characteristics comprising primary fibers (16) and bicomponent fibers, the bicomponent binder fibers (20) having a principal polymer component (22) and a binder polymer component (24), the binder component having a softening point lower than the softening point of the principal component, and at least a portion of the binder polymer component having been heated to bind the bicomponent fibers and the primary fibers to themselves and to each other.

15. The acoustical insulation product (10) of claim 14 in which the principal polymer component (22) and binder polymer component (24) are in a core/sheath arrangement.

16. The acoustical insulation product (10) of claim 14 in which the binder component (24) is a thermoplastic material.

17. The acoustical insulation product (10) of claim 14 in which the primary fibers (16) are bicomponent glass fibers.

18. The acoustical insulation product (10) of claim 14 wherein the acoustical insulation product has been subjected to a mechanical interlocking process for enhancing product integrity.

19. The acoustical insulation product (10) of claim 18 in which the acoustical insulation product has been subjected to a needling process for enhancing product integrity.

20. The acoustical insulation product (10) of claim 14 which has been molded.

21. The acoustical insulation product (10) of claim 20 wherein the acoustical insulation product is capable of being re-molded.

22. The acoustical insulation product (10) of claim 14 in which the primary fibers (16) are glass fibers having a diameter within the range of from about 3 to about 15 microns, the glass fibers being present in an amount that is within the range of from about

20 to about 90 percent by weight of the whole acoustical insulation product, exclusive of facings, and in which the bicomponent binder fibers (20) are present in an amount within the range of from about 10 to about 80 percent by weight.

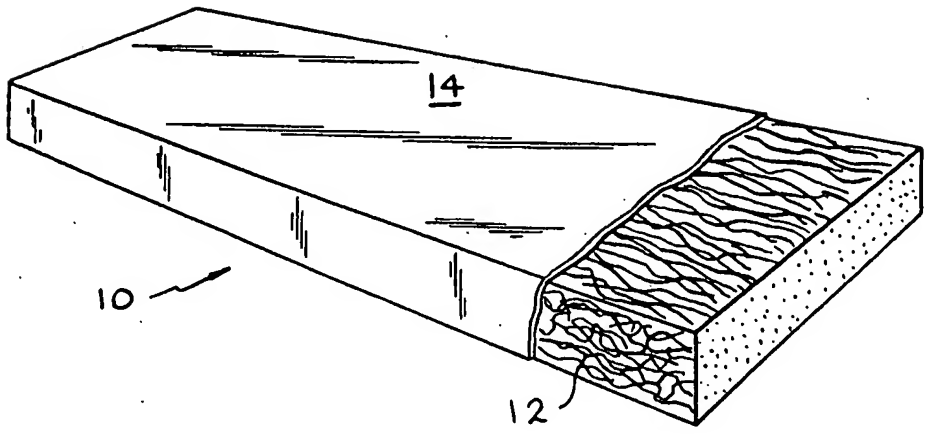
23. The acoustical insulation product (10) of claim 22 in which the bicomponent fibers (20) include a core of polyethylene terephthalate and a sheath of polyethylene terephthalate.

24. The acoustical insulation product (10) of claim 22 in which the glass fibers (16) are bicomponent glass fibers.

25. The acoustical insulation product (10) of claim 22 wherein the glass fibers (16) have a diameter in the range of about 5 to about 9 microns.

26. The acoustical insulation product (10) of claim 22 wherein the bicomponent binder fibers (20) are present in the range of from about 20 to about 60 percent by weight.

FIG. 1



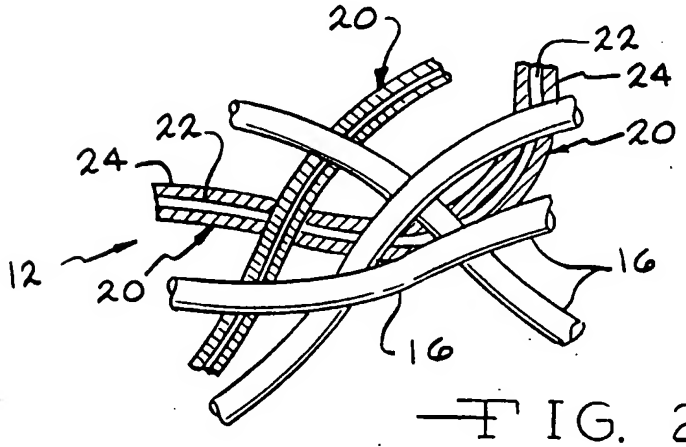


FIG. 2

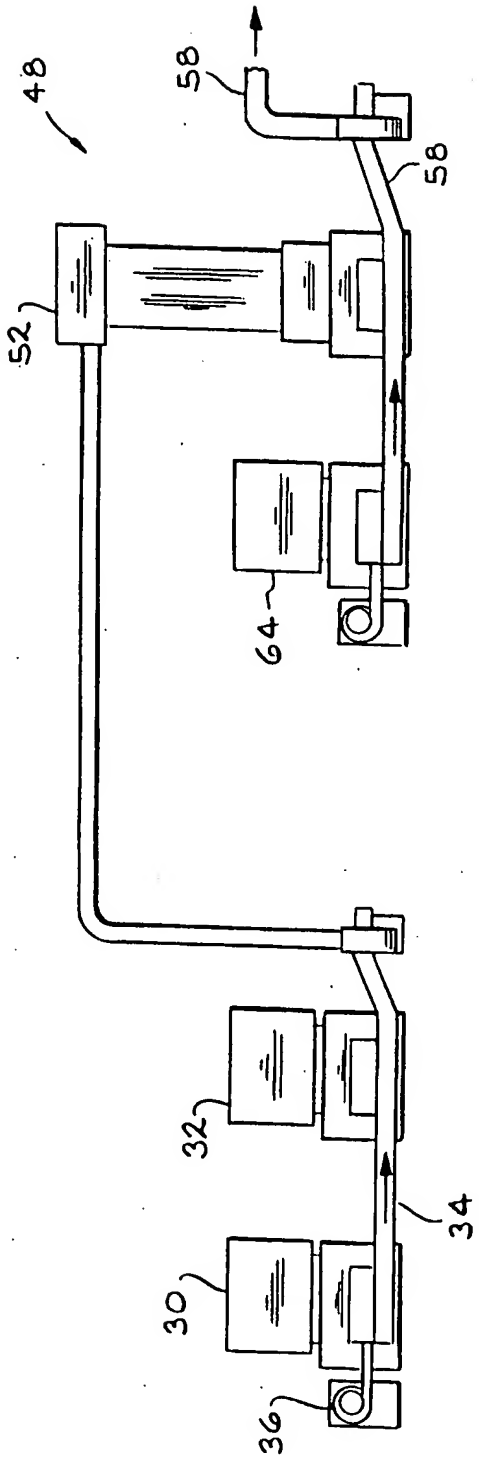


FIG. 3

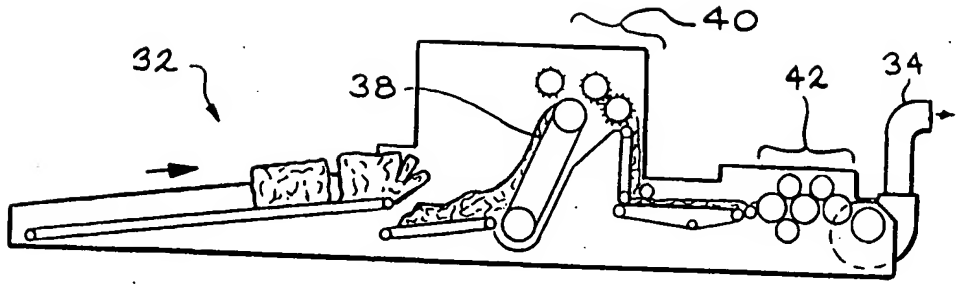


FIG. 4

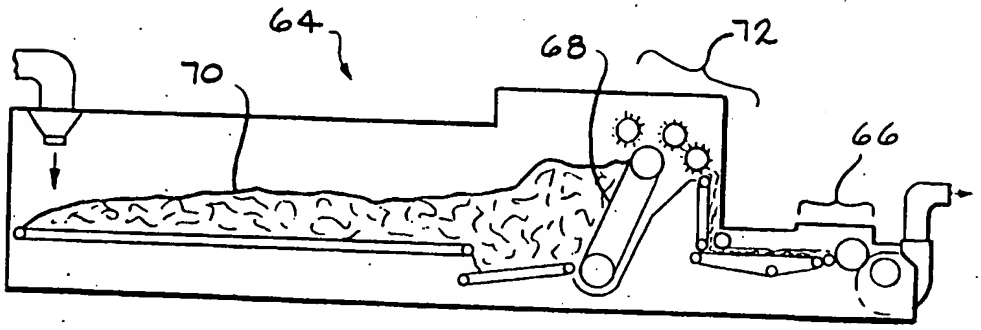


FIG. 5

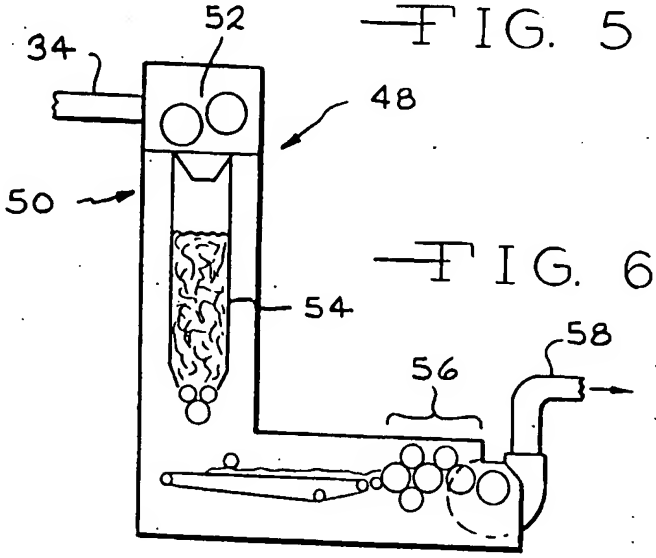


FIG. 6

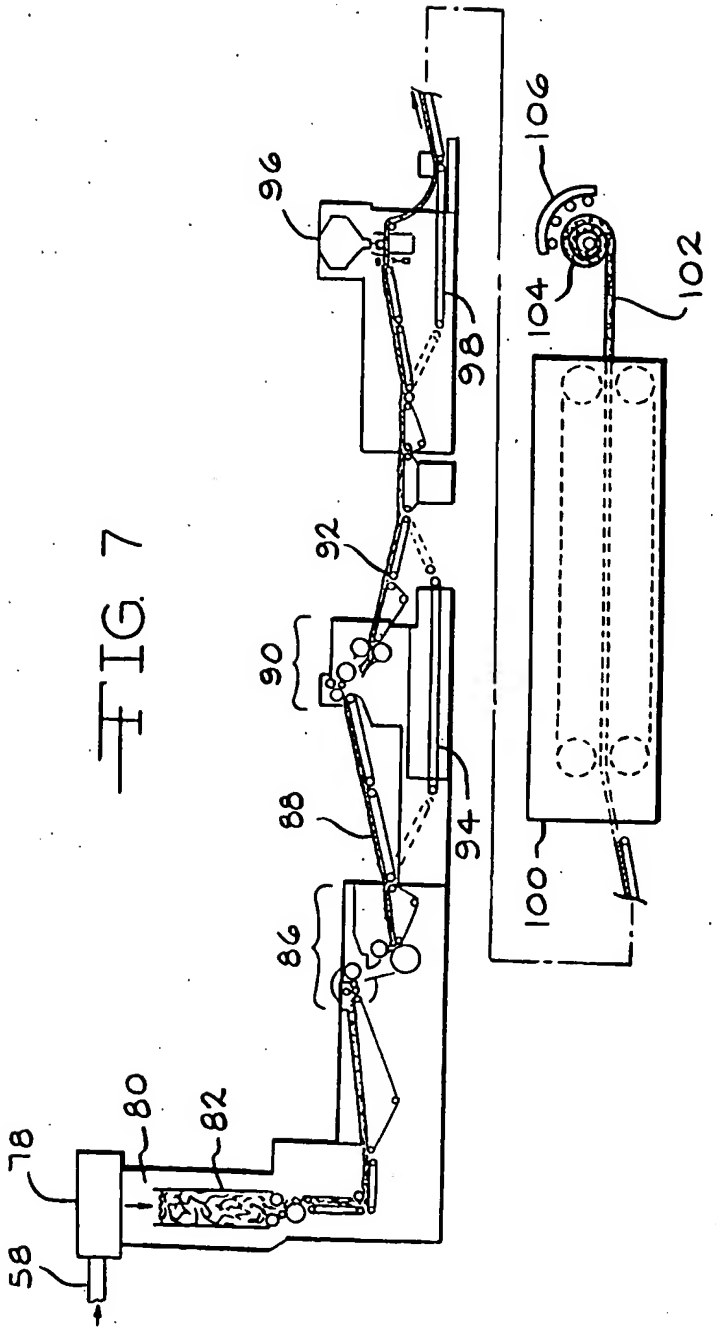


FIG. 7

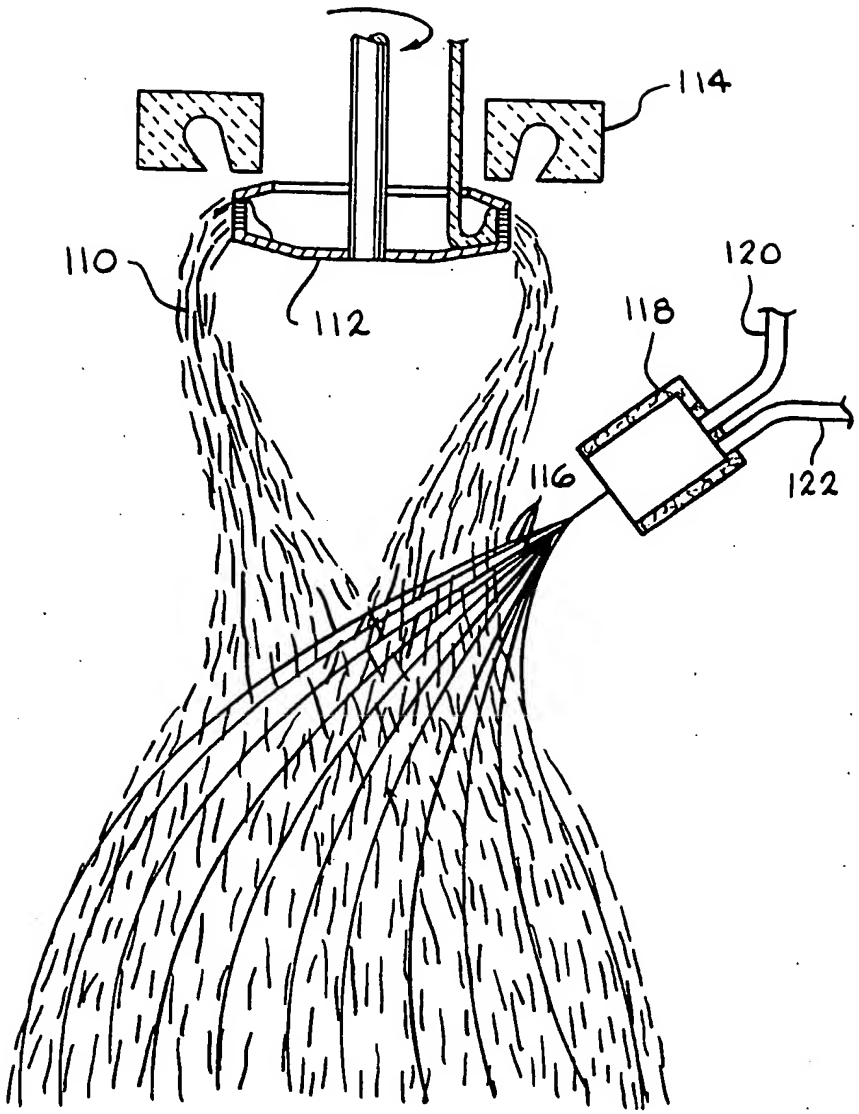


FIG. 8

INTERNATIONAL SEARCH REPORT

Int. tional Application No
PCT/US 00/26540

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E04B1/74 D04H1/54 D04H1/60 D04H13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E04B D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 841 081 A (THOMPSON DELTON R ET AL) 24 November 1998 (1998-11-24) examples column 6, line 64 -column 7, line 22 column 7, line 55 -column 11, line 22 ---	1,8,9, 14-16
X	US 5 298 694 A (THOMPSON DELTON R ET AL) 29 March 1994 (1994-03-29) cited in the application column 5, line 16 - line 41; examples 7-9 ---	1,8-10, 14-16
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 January 2001	08/02/2001

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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